

Recent Advances in Microwave Planar Filter Technology

Jiasheng HONG^{1(a)}, Jia NI¹, Francisco CERVERA¹, and Laura HEPBURN¹, Nonmembers

SUMMARY This invited paper aims to present an overview of our recent research and development (R&D) of advanced microwave planar filters, in particular with miniaturization and/or electronically tunable/reconfigurable functionalities, which are in demand for future communication/radar systems as well as emerging wireless applications.

Key words: microwave filters, planar filters, multilayer filters, tunable filters, reconfigurable filters

1. Introduction

Recently, there is an increasing demand for miniature and/or tunable/reconfigurable microwave planar filters. For the filter miniaturization, we have exploited multilayer liquid crystal polymer (LCP) technology [1]–[11]. LCP has been popular not only due to its superior electrical properties up to millimeter-wave frequencies [12], but also because itself is an excellent packaging material for system-on-package [13]. It has a stable low dielectric constant around 3 and low dielectric loss tangent 0.0025 over a wide frequency range. Compared to LTCC, LCP has much lower processing temperature around 280°C. Although LCP has lower dielectric constant than LTCC, which makes it more challenging for RF/Microwave circuit miniaturization, it makes LCP circuit design less sensitive to fabrication tolerances than LTCC, which is very important for multilayer laminated circuit. Although some cheaper PCB laminates can be used for miniature filter designs, LCP offers much higher flexibility on circuit thickness and a very strong coupling can be achieved with a separation as small as 25 μm . This is very important for the design of low frequency filters that requires large capacitances. Furthermore, in the LCP adhesive system [14], circuit layers (core films) and prepreg layers (bonding films) have almost the same characteristics, such as thermal expansion coefficient, dielectric constant and water absorption, which can be a great benefit for both filter designs and practical applications.

In addition to the filter miniaturization, electronically tunable or reconfigurable filters are also in increasing demand in current and emerging multifunctional communication and radar systems owing to their efficiency in use and flexibility in control of frequency spectrum. In general, to develop an electronically tunable or reconfigurable filter,

active switching or tuning elements such as semiconductor p-i-n and varactor diodes, RF microelectromechanical systems (MEMS) or other functional material-based components including ferroelectric capacitors need to be integrated within a passive filtering structure [15]. Planar filters can conveniently facilitate this kind of integration with a small size and to this end we have carried out R&D for tunable or reconfigurable planar filters are based on planar structures [16]–[33].

In the following parts, several typical advanced planar filters resulting from our R&D are highlighted.

2. Packaged LCP Filters

This section is to demonstrate the methods for integrating filters within a package as one of the stages in the manufacturing process, using LCP multilayer technology. Including the packaging in the manufacturing process will reduce the number of processes needed and thus, the final cost of the solution.

2.1 Hermetic Packaged UWB Filter

The concept for packaging with CPW input/output (I/O) ports is illustrated in Fig. 1, which consists of two layers of LCP substrate holding the packaged device in between. The bottom layer will interface between the host board and the packaged device through a CPW structure. Since the CPW structure has both signal and ground on the same plane, it will simplify the connection of the device to the host board. On the other side, the top layer is the ground plane for both the CPW structure and the packaged device. In this way, the CPW becomes grounded-CPW (G-CPW). However, to simplify, G-CPW will be referred as CPW in this paper. CPW and ground plane are connected through via-holes. On top



Fig. 1 Main concept for packaging with CPW input/output (I/O) ports.

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¹The authors are with Institute of Sensors, Signals & Systems, School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, UK.

a) E-mail: J.Hong@hw.ac.uk

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Recent Advances In Microwave Technology

**Roman Szewczyk, Małgorzata
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Recent Advances In Microwave Technology:

Recent Advances in Microwave Technology Bharathi Bhat,1993 *Microwave Technologies - Recent Advances and New Trends and Applications* Hüseyin Şerif Savci,2024-06-05 This book is intended to serve as a technology reference for graduate students researchers and engineers on various microwave engineering subjects The chapters encompass a wide range of topics in microwave engineering from its core science for developers to state of the art applications for its users Besides the fundamental technology related chapters such as advanced analysis techniques of microstrip structures using the finite difference time domain in Julia and tunable microwave filter designs there are chapters covering implementations of microwave technology in different applications such as medical imaging medical heating food drying and remote sensing for radio astronomy The chapters are written based on a collection of theses research papers and case analyses by field experts and academicians The title of the book reflects that each chapter elaborates on a recent advancement or a brand new application of microwave engineering **International Symposium on Recent Advances in Microwave Technology**

,1989 **Recent Advances in Mechanical Engineering** K.M. Pandey,R.D. Misra,P.K. Patowari,U.S. Dixit,2021-01-10 This book presents the select proceedings of the International Conference on Recent Advancements in Mechanical Engineering ICRAME 2020 It provides a comprehensive overview of the various technical challenges faced their systematic investigation contemporary developments and future perspectives in the domain of mechanical engineering The book covers a wide array of topics including fluid flow techniques compressible flows waste management and waste disposal bio fuels renewable energy cryogenic applications computing in applied mechanics product design dynamics and control of structures fracture and failure mechanics solid mechanics finite element analysis tribology nano mechanics and MEMS robotics supply chain management and logistics intelligent manufacturing system rapid prototyping and reverse engineering quality control and reliability conventional and non conventional machining and ergonomics This book can be useful for students and researchers interested in mechanical engineering and its allied fields

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energy losses The communications industry makes extensive use of thermal imaging since overheating and cracks in insulation may cause the unscheduled shut down of expensive equipment There is now a special thermal imaging system for the examination of very large scale integrated circuits to help in the development of diagnostic tools for examining circuits which now have features of 1 micron in size making the conventional method of mechanical probing impossible This revolution in probing will enable us to maintain the high levels of quality control which are essential in the communications industry

Recent Advances in Systems, Control and Information Technology Roman Szewczyk, Małgorzata Kaliczyńska, 2016-11-29 This book presents the proceedings of the International Conference on Systems Control and Information Technologies 2016 It includes research findings from leading experts in the fields connected with INDUSTRY 4.0 and its implementation especially intelligent systems advanced control information technologies industrial automation robotics intelligent sensors metrology and new materials Each chapter offers an analysis of a specific technical problem followed by a numerical analysis and simulation as well as the implementation for the solution of a real world problem

Proceedings of the Second International Symposium on Recent Advances in Microwave Technology, September 4-8, 1989, Beijing People's Republic of China International symposium of recent advances in microwave technology [1989 ; Beijing people's Republic of China], 1989

Proceedings of 3rd International Symposium on Recent Advances in Microwave Technology (ISRAMT '91), August 18-21, 1991, Reno, Nevada, U.S.A. Banmali S. Rawat, Krishna K. Agarwal, 1991

Recent Advances in Electromagnetic Theory H.N. Kritikos, Dwight L. Jaggard, 2012-12-06 The contributions of this book represent only a small sample of the work of the many researcher electromagneticians who have had the pleasure of being associated with Professor Papas either as students or as colleagues Many of us continue to work in the many and diverse areas that modern electro magnetism encompasses There is however a common thread that was derived from our association with Professor Papas that has greatly influenced our thinking and technical style of expression Professor Papas from his studies at Harvard brought with him to Pasadena a very fundamental and classical point of view that was instilled in all those who were associated with him He saw research problems as a combination of fundamental physical and mathematical principles and the electromagnetic reality He searched and demanded clarity and often in the rather involved and engaging discussions which took place in his office he demanded that the baby picture be clearly drawn on the blackboard This requirement certainly for some of us who were working in widely varied subjects ranging from relativistic plasmas to almost periodic media has forced us to reexamine the fundamentals The clear and lucid marriage of fundamental concepts to applications has been the trademark of Professor Papas's intellectual tradition and has greatly influenced the thinking of all of those who have associated with him

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biomaterials materials for environmental studies DFT and solar simulation of materials perovskite and double perovskite materials luminescent materials smart materials materials for energy conversion and storage smart materials advanced functional materials polymeric materials composites liquid crystals materials for sustainable development nanomaterials and thin films smart devices and quantum dots synthesis technique and characterization tools with application in smart devices The book will be useful for researchers and professionals working in various areas of materials science Recent Advances And Cross-century Outlooks In Physics: Interplay Between Theory And Experiment Cheuk-yin Wong,Pisin Chen,2000-04-05

Recent Advances in Postharvest Technologies, Volume 1 Nouredine Benkeblia,2024-09-09 The elapsing time from producer to consumer has significantly increased as a result of food marketing and trade globalization Consequently maintaining quality along the food value chain is becoming a significant challenge Postharvest losses are considered a major component of food loss and waste in the supply chain from farmers to consumers due to improper handling storage transport preservation techniques and spoilage Postharvest science aims to extend the shelf life of fresh and perishable commodities and to reduce heavy losses thereby contributing to food security While significant progresses have been made in postharvest preservation and shelf life extension the continuous development of emerging technologies have changed our vision on postharvest science Furthermore recent advancements in molecular engineering of horticultural crops for quality improvement the development of genomics transcriptomics proteomics and metabolomics have led to a better understanding of the physiology and the biochemistry of the senescence processes resulting in better preservation and improved production of fresh crops This two volume work focuses on innovative technologies that extend and preserve shelf life of fruits and vegetables Volume 1 offers a review on the state of the art modern technologies in the postharvest field The accompanying Volume 1 explores advanced and novel technologies after harvest particularly the application of nanotechnologies to packaging materials Recent Advances in Edible Fats and Oils Technology Yee-Ying Lee,Teck-Kim Tang,Eng-Tong Phuah,Oi-Ming Lai,2022-03-15 This book is written by international experts with both academic and industrial credentials It presents for the first time a collection of up to date scientific advances in the area of edible fats and oils technology over a span of 10 years from 2009 to the year 2019 The book covers the existing and recent advanced techniques adopted in the edible fats and oils research and touches on the processing and modification to the traceability and sustainability issues of fats and oils Some recent technologies like supercritical carbon dioxide microwave ultrasound and enzymatic assisted processes ionic liquid enzymatic processes biosensor and membrane technology are presented in the book The book aims to provide the technologists and researchers in research development and operations in the edible fats and oils industries with critical and readily accessible information on the recent advances in the field The book is divided into three broad sections Fats and Oils Chemistry and Processing Fats and Oils Modification and Health Implications and Fats and Oils Safety Social Environmental and Economic Impacts It is an extremely comprehensive and valuable resource which serves as an essential

reference for students and lipid scientists from academia or industry *Recent Advances in Mechanical Engineering* Sanjay Yadav, Yogesh Shrivastava, Shanay Rab, 2024-09-06 This book presents the select proceedings of the 3rd International Conference on Mechanical and Energy Technologies ICMET 2023 It covers a wide range of topics including robotics and automation advanced manufacturing technologies materials science and engineering thermodynamics fluid mechanics automotive engineering and interdisciplinary areas such as the application of computer science and electronics in mechanical engineering This is a useful resource for researchers and professionals in mechanical engineering **Recent Advances in Material, Manufacturing, and Machine Learning** Bjorn Schuller, Rajeev Gupta, Rakesh Mote, Abhishek Sharma, J.P. Giri, R.B. Chadge, 2024-06-17 The main aim of the 2nd international conference on recent advances in materials manufacturing and machine learning processes 2023 RAMMML 23 is to bring together all interested academic researchers scientists engineers and technocrats and provide a platform for continuous improvement of manufacturing machine learning design and materials engineering research RAMMML 2023 received an overwhelming response with more than 530 full paper submissions After due and careful scrutiny about 120 of them have been selected for presentation The papers submitted have been reviewed by experts from renowned institutions and subsequently the authors have revised the papers duly incorporating the suggestions of the reviewers This has led to significant improvement in the quality of the contributions Taylor Francis publications CRC Press have agreed to publish the selected proceedings of the conference in their book series of Advances in Mechanical Engineering and Interdisciplinary Sciences This enables fast dissemination of the papers worldwide and increases the scope of visibility for the research contributions of the authors *Proceedings of 2nd International Symposium on Recent Advances in Microwave Technology (ISRAMT '89), September 4-8, 1989, Beijing, People's Republic of China* Banmali Rawat, Siyong Zhou, 1989 *Recent Advances in Activated Carbon* Ho Soon Min, Heri Septya Kusuma, Yogesh Chandra Sharma, 2024-12-26 The world's activated carbon market volume has increased rapidly in recent years due to environmental regulations It is being used in a variety of fields including water treatment air purification and food processing This volume in the Green Chemical Innovations and Sustainability Series studies the physical biological and chemical modification of activated carbon to enhance the adsorption performance Recent experimental results indicating improved adsorption capacity are presented as well as novel applications using activated carbon The authors focus on identifying potential precursors from agricultural waste municipal waste and industrial waste and investigate toxic pollutants Features Demonstrates how researchers can produce synthetic adsorbents activated carbon via agricultural waste industrial waste and household waste Describes the actions of adsorption capacity or percentage removal with respect to factors affecting the adsorption process Investigates activated carbon's removal efficiency of dyes organic compounds pharmaceutically active compounds heavy metals pesticides fungicides herbicides antibiotics and other toxic pollutants Discusses the search for low cost adsorbents that can be produced by using agricultural wastes industrial wastes and natural

materials **Electromagnetic Technologies for Medical Diagnostics** Lorenzo Crocco, Panos Kosmas, 2019-04-02
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International Symposium on Recent Advances in Microwave Technology and Future Challenges, August 15-16, 1986, University of North Dakota, Grand Forks, North Dakota University of North Dakota. Department of Electrical Engineering, 1986

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